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PRODUCTION OF COMPLEX CASTING
[Fukugo chuzohin no seizohoho]

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Specification

/329*

1. Name of this invention

Production Of Complex Casting

2. Claims

Production of complex casting with the following characteristic:

After a material for complex is mixed with or adhered to a foaming organic agent and foamed in a mold to produce an expendable model, a molten metal is injected in a mold filled with said expendable model so as to substitute the organic agent in the expendable model with a molten metal.

3. Detailed Explanation of this Invention

[Industrial Field]

This invention pertains to a production method of complex casting containing a material for complex (e.g., reinforced fiber, ceramics, and black lead).

[Conventional Technology]

To produce a conventional complex casting, a material for complex **4** is mixed in a molten metal **5** used as a base material, and the molten metal **5** is poured in a mold **8** (see Fig. 9), or as shown in Fig. 10, porous ceramics **11** (material for complex) is placed in a mold **8** into which a molten metal **5** is injected so as to produce a

* Numbers in the margin indicate pagination in the foreign text.

complex casting having ceramics **11** at the area requiring abrasion resistance (refer to Patent No. 61-3649).

[Problems to Be Solved by this Invention]

The problem with the method shown in Fig. 9 is that, when mixing a material for complex in a molten metal, certain materials (e.g., carbon fiber, ceramics, black lead) float from the molten metal due to the difference of specific gravity. As a result, only an amount equivalent to 5% or less of total amount can be actually injected in a mold, which is a fairly inefficient yield. Also, even if it can be injected in a mold, the material floats in the mold and cannot be set at a required location in the mold. Furthermore, since significant fluctuation of material yield results in considerable instability of material distribution ratio, an intended complex casting containing a material for complex cannot be easily produced.

Also, with the conventional method shown in Fig. 10, a special device is required for fixing said ceramics in order to prevent the ceramics from being pushed away by the molten flow. Therefore, this method is only usable when the material for complex can be inserted in a mold as shown in Fig. 10, thus limiting its application range. /330

[Method to Solve the Problems]

To solve the problems described above, this invention provides the following complex casting production method:

After a material for complex is mixed with, or adhered to, a foaming organic agent and foamed in a mold to produce an expendable

model, a molten metal is injected in a mold filled with said expendable model so as to substitute the organic agent in the expendable model with a molten metal.

With this production method, a material for complex can be appropriately positioned at necessary areas in a complex casting.

Said foaming organic agents are various types of organic agents containing a foaming agent. Typical example is a powder form of polyethylene. Also, typical examples of materials for complex are carbon fiber, aluminum fiber, ceramics, and black lead.

The following explains the practical operation of this invention while referring to figures.

Figure 1 is a diagram showing the production process of a random type complex casting that produces a casting by randomly mixing short fibers and a particle form of material for complex (2) in a metal **6**. Process (a) in the figure mixes a powder form of foaming organic agent **1** and material for complex **2**.

Next, in Process (b), the mixture is blown to a metallic mold **3** heated to 150 - 200°C to cause foaming to create an expendable model **7** shown in Process (c).

In Process (d), after a mold **8** is filled up with the expandable mold **8**, a molten metal **5** is injected into the mold **8**. Once the metal **5** is injected into the mold **8**, the foamed organic agent **4** in the expendable model **7** is substituted by the molten metal **5**, eliminating the expendable model **7**. Thus, a random type complex casting

consisting of a metal **6** and material for complex **2** can be produced as shown in Process (e).

Note that, after injecting a molten metal **5** in Process (d), an appropriate pressure may be applied to the molten metal **5** in order to strongly adhere the molten metal **5** and material for complex **2**.

Also, the mold **8** in Process (d) must have gas exhaust holes at applicable locations so as to exhaust the gas produced by the vanishing foamed organic agent.

Figure 2 is a diagram showing the production process of aligned complex casting that aligns a material for complex (9), such as reinforced fibers at necessary locations in the mold. In this case, in process (a), the reinforced fibers **9** receive an appropriate surface tension and are aligned in a tension-providing device **10**.

Then, after aligned reinforced fibers **9** are inserted into a 150 - 200°C metallic mold **3** shown in Step (b), a particle form of foaming organic agent 1 is filled in a metallic mold **3** in order to adhere the foaming organic agent to the reinforced fibers and foamed to create an expendable model **7** shown in Process (c). After that, the tension device **10** is cut off from the reinforced fibers **9**.

Next, at Process (d), the expendable model **7** is filled in the casting **8** into which a molten metal **5** is injected. Once the molten metal **5** is injected, the foamed organic agent **4** in the expendable model **7** is substituted with the molten metal **5**. Subsequently, an aligned complex casting product consisting of a metal **6** and material

for complex (i.e., reinforced fibers **9**) can be produced as shown in Process (e).

Note that as described with the random type complex casting product shown in Fig. 1, a pressure casting can be applied to strongly adhere the molten metal and material for complex.

Furthermore, during the foaming molding process (b) of a random type complex casting shown in Fig. 1, different kinds of complex castings can be produced by adjusting the molding content. For example, a material for complex may be eliminated when creating an expendable model (i.e., expendable model consists of foaming organic agent only); or different kind of material for complex or expendable model having a different weight ratio may be used.

The following explains the operational examples of this invention while referring to Figs. 4 - 8:

Operational example 1 (Fig. 4):

Production of reinforced fiber type metal (CFRM):

Nickel-plated short carbon fibers were mixed in polyethylene powder (particle diameter = 1 mm) at a volume ratio of 15% and blown onto a 150°C metallic mold to produce an expendable model. Next, this model was buried in a CO_2 sand mold, into which 1150°C Cu molten liquid was injected. As a result, a reinforced fiber type hollow /331 mold (CFRM) consisting of Cu 10 and carbon fibers 11 was produced.

Operational example 2 (Fig. 5):

Production of guide shoe for pressure-extending a seamless pipe containing black lead:

After black lead (20 μ) was nickel-plated and mixed in polyethylene powder at a volume ratio of 10%, the mixture was blown to a 150°C metallic mold to produce an expendable model. Next, this model was buried in a sand mold to, into which an austenite type stainless steel molding liquid (content: C = 1.18, SiO = 80, Mn = 0.84, P = 0.031, S = 0.024, Mi = 34.8, Cr = 34.5, Mo = 1.48, W = 1.51, Cu = 5.12 wt% and remaining portion = Fe) was injected. As a result, a seamless pipe pressure-extending guide shoe consisting of an austenite type stainless steel 13 containing black lead 12 was produced (see Fig. 5).

This guide shoe containing black lead could provide excellent abrasion resistance and sintering resistance. Therefore, when 13% Cr copper seamless pipe was pressure extended, 40 or more pipes could be processed without exchanging the guide shoe. However, when a conventional guide shoe was used in the same way for pressure-extending pipe, after only four pipes were processed, the guide show had to be replaced.

Operational example 3 (Fig. 6):

Production of carbon-immersed material:

After 5 μ diameter carbon powder was mixed in polyethylene powder, the mixture was blown to a 150°C metallic mold shaped into a

gear, providing a 10 mm thick layer from the inner surface of metallic mold (area equivalent to the tooth surface).

Then, polyethylene powder not containing carbon is blown to the inside of metallic mold to produce an expendable model. This model was set in a metallic mold.

Then, after 1150°C melted copper containing 0.1% C was injected into the mold, the content was pressure-molded at 15 Kg/mm^2 Cu. As a result, a gear 22 consisting of a curved area 14 having 0.8% C and remaining of area having 0.1% C copper was produced.

Operational example 4 (Fig. 7):

Production of complex bend pipe:

Chrome carbonate was mixed in polyethylene powder and blown to the inner surface of a 150°C bend pipe metallic mold until the thickness reached 10 mm. Then, polyethylene powder not containing chrome carbonate was blown until thickness reached 15 mm. Thus, 25 mm thick bend pipe expendable model was created.

This expendable model was buried in a sand mold to create a casting, to which 1550°C SC 48 casting copper liquid was injected. As a result, the produced complex bend pipe 23 had an outer surface consisting of high Cr copper 18 and inner surface consisting of SC48 cast steel 17, with excellent abrasion resistance.

Operational example 5 (Fig. 8):

Production of connecting rod made of a reinforced fiber metal (FROM):

After aluminum fibers were plated with aluminum, to which appropriate tension was applied, those fibers were aligned using a tension device. Next, the aligned aluminum fibers were inserted into a 150°C metallic mold, to which polyethylene powder was blown to create an expendable model.

This expendable model was buried in a black lead sand mold to create a casting, into which 750°C Al alloy melted liquid was injected. As a result, the produced connecting rod 24 was made of a reinforced fiber type metal (FRM) consisting of an aluminum fiber 19 made of an Al alloy as its base material.

[Effectiveness of this invention]

This invention can provide the following benefits:

(1) As a material for complex (e.g., reinforced fibers, ceramics, black lead) can be appropriately positioned at necessary locations in a metallic base material of a complex casting, various kinds of complex casting products can be easily produced as desired.

(2) The yield of material for complex can be significantly improved.

(3) Various kinds of complex casting products can be produced using the same production steps.

(4) By applying this invention to a production that requires carbon immersion as explained in Operational example 3, the conventional lengthy carbon immersion process can be eliminated.

(5) By applying this invention to a fiber-reinforced part as explained in Operational example 5, the conventionally required alignment of aluminum fibers in a casting or difficult and lengthy process of burying a tension-device in a mold can be eliminated. Also, the problem of fiber-incision caused by hot liquid flow can be eliminated. /332

4. Simple Explanation of the Figures

Figure 1 is a diagram showing the production process of random type complex casting. Figure 2 is a diagram showing the production process of an aligned complex casting. Figure 3 is a diagram explaining the production process of double layer expendable model of this invention. Figures 4, 5, 6, 7, and 8 are diagrams showing the complex castings produced in operational examples. Figures 9 and 10 are diagrams of a conventional production method.

1…Particle form of foaming organic agent; 2…Material for complex; 3…Metallic mold; 4…Organic agent; 5…Molting metal; 6…Metal; 7…Expendable model; 8…Casting; 9…Material for complex (reinforced fibers); 10…Cu; 11…Carbon fiber; 12…Black lead; 13…Austenite type stainless steel; 14…Cross-sectional surface of immersed carbon layer; 15…0.1% carbon copper; 16…High Cr casting; 17…SC46 casting; 18…Al alloy; 19…Aluminum fiber; 20…Fiber reinforced metal; 21…Pipe pressure

extending guide shoe; 22…Gear immersed in carbon; 23…Complex bend pipe; 24…Connecting rod

Figure 1

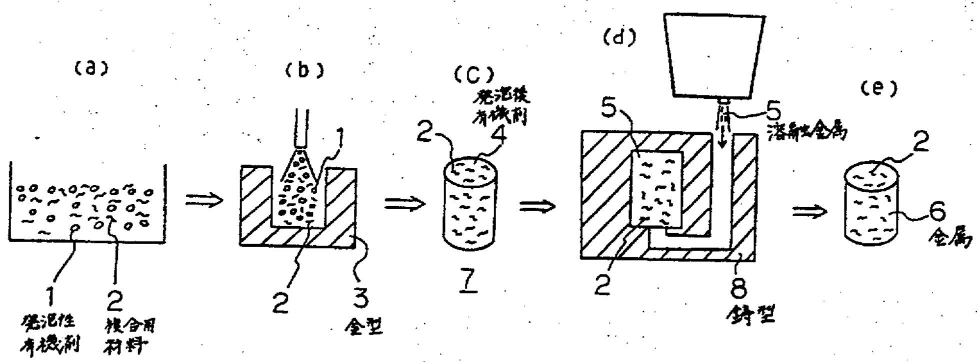

Figure 2

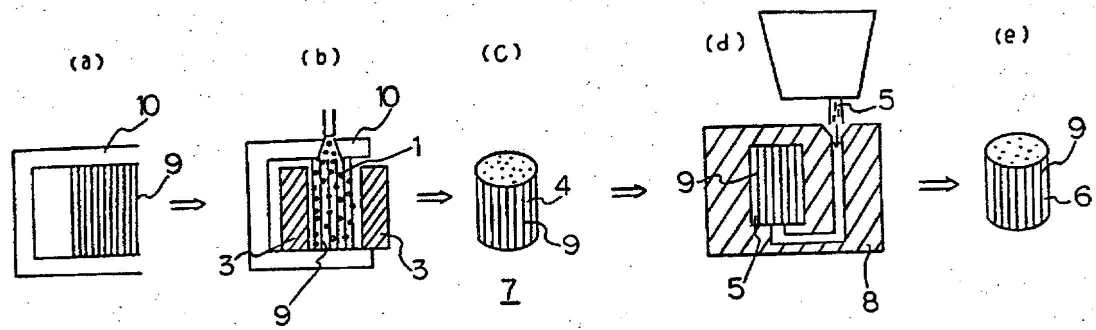

Figure 3

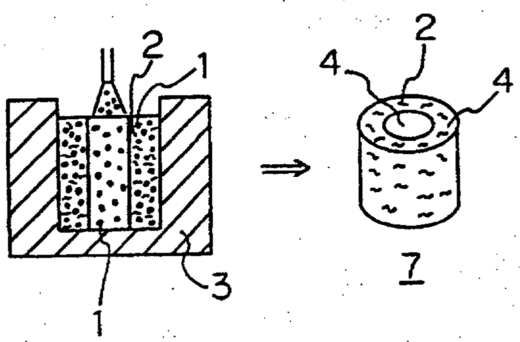

Figure 4

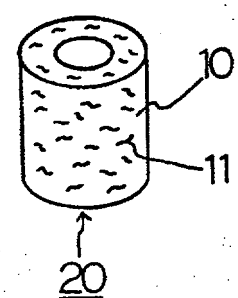

Figure 5

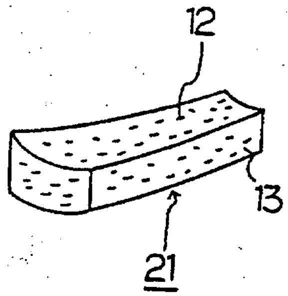

Figure 6

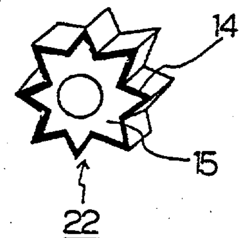

Figure 7

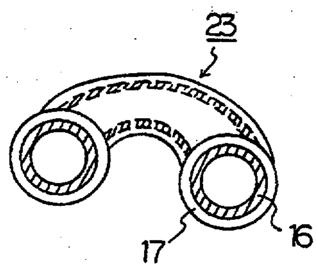

Figure 8

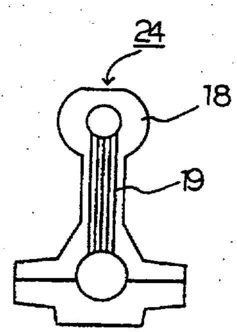

Figure 9

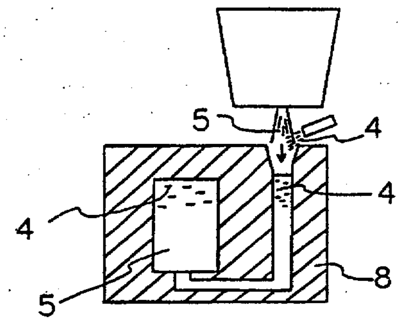

Figure 10